Embryos — the evolutionary boundary of kingdoms of organisms

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Abstract: Bioevolution is still a main puzzle and attracts many scientists to research on it. Here I present that organisms have two important properties, definite structure and self-reproduction. Based on the number and connection of the structural units, organisms can be divided into three groups, unicellular, particellular and polycellular organisms. It can be called polycellular evolution that organisms evolve from unicellular, particellular to polycellular. Also it can be called diploid evolution that organisms evolve from haplobes to diplobes, two groups based on the reproductive differences. Some concepts like spore, zygote and embryos are redefined in the paper. Moreover, I present that embryos are the most important boundary of bioevolution and organisms can be divided into two evolutionary phases, the lower and the higher. The lower organisms, Kingdom Microbia (kingd. nov.), are inembryonate, which include Acytophyla (phyl. nov.), bacteria, protozoa, fungi and inembryonate algae. The higher organisms are embryonate and have two branches, Kingdom Plantae and Kingdom Animalia. Plantae are sessile and, autotrophic or sporogenic, which include higher plants and Nudembryophyta (phyl. nov.). Animalia are heterotrophic and, motile or gametogenic, which include all multicellular animals. The new system, which reflects the two important phases of bioevolution and two branches of higher organisms, can really correct the problem of different kingdoms in different researches or by different researchers.

Keywords: Particellular organism; Polycellular organism; Kingdom Microbia, kingd. nov.; Kingdom Plantae; Kingdom Animalia; Phylum Nudembryophyta, phyl. nov.; Phylum Acytophyla, phyl. nov.

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Along with the *Origin of species* written by Ch. R. Darwin and published in 1859, the evolutionary theory was established. Now evolutionary theory has become a principle in the research of life science and even others such as chemistry, physics, mathematics, geology and sociology. However, how to think the course of bioevolution is still a main puzzle and attracts many scientists to carry out research on it.

Organisms are constitutive of one or more structural units, cell or virosome. Each structural unit has all genes of the organisms. Unicellular organisms are constitutive of only one unit, which include viruses, bacteria, protozoa and some algae. Multicellular organisms are constitutive of many cells such as most algae, fungi, higher plants and animals. It is accepted that the unicellular organisms are the lower evolutionary phase (Stern *et al.* 2004; Liu and Mei 1997; Nicklin *et al.* 1999; Zhou 2002; Proscott *et al.* 2003; Whittaker 1969; Leedale 1974; Chen, Sh. X. & Chen, Sh. Y. 1979)

The cellular connection of multicellular organisms includes two styles, the particellular and the polycellular. Particellular organisms are constitutive of part interdependent cells connected by protoplasms or cytoderms, which usually are filaceous, such as some filaments of algae and mycelia of fungi. Polycellular organisms are constitutive of many interdependent cells connected by some connectors out of cells such as mesoglea, plasmodesms and conjunctional complex, which include some algae, higher plants and multicellular animals. Since all higher plants and animals are polycellular, it can be concluded that the evolutionary course is from unicellular, particellular to polycellular, which can be called polycellular evolution.

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Reproduction, the other one of the most important natural properties of organisms, is evolutionary too. Meiosis and fertilization has the most important evolutionary meaning. Based on it, organisms can be divided into two groups: haplobes and diplobes. The evolutionary course is from haplobes to diplobes, which can be called diploid evolution. Haplobes are broad haploid organisms. They have no sexual reproduction, have sexual reproduction but not fertilized, or have fertilization but zygotes directly have meiotic division. Therefore, the gene numbers of haplobes are the same as their gametes (if have). Haplobes include viruses, bacteria, protozoa, and most fungi and algae. Diplobes are multicellular organisms developed from zygotes, reproductive cells of diploid produced by fertilization, the syngamy of female and male gametes. So, the gene numbers of diplobes (2n) are double of their gametes (n).

Zygotes of diplobes have two development styles. One is that zygotes develop into particellular organisms, which include some fungi and algae. The other is that zygotes develop into embryonate organisms. Embryos, developed from zygotes to young polycellular diplobes, are the most important boundary of bioevolution. It is easily concluded that embryonate organisms are higher, and inembryonate organisms are lower in evolutionary course. Therefore, organisms can be divided into two important phases: the lower organisms and the higher organisms.

The lower organisms are inembryonate, which can be called Kingdom Microbia (Microbia, kingd. nov. organismi inembryonati) because they are usually smaller than higher organisms. Microbes, a group of organisms, have been widely accepted (Nicklin *et al.* 1999; Zhou 2002; Proscott *et al.* 2003), but they only are a group of organisms based on the size (cannot be seen without the use of a microscope (Nicklin *et al.* 1999), < 0.1 mm (Zhou 2002) or < 1 mm (Proscott *et al.* 2003), and have not been formally proposed as a kingdom. Accordingly, Microbia are a new kingdom, which include Phylum Acytophyla (Acytophyla, phyl. nov. organismi acellulares), bacteria, protozoa, fungi and inembryonate algae. Acytophyla, a new phylum, are acellular

organisms.

The higher organisms are embryonate and have two branches: Kingdom Plantae and Kingdom Animalia, proposed by C. von Linneaus (1735) in *Systema naturae*, based on the lifestyles and trophic styles. Along with the development of biology, the boundary should have been amended. My opinion is that the sexual reproductive styles of higher organisms have the same important taxonomic meanings as lifestyles and trophic styles.

There are two styles of sexual reproductions of higher organisms, sporogeny and gametogeny. Sporogeny means that the products of meiosis are spores, reproductive cell of haploid, and the life cycle has the alternation of generations of sporophyte and gametophyte (Fig. 1 A). Gametogeny means that the products of meiosis are gametes, fertilizable spores, and the life cycle has not the alternation of generations (Fig. 1 B). Almost all plants are sporogenic except *Fucus* L. etc. and almost all animals are gametogenic except some species being half-gametogenic (parthenogenesis) such as Rotifera and some insects. It is need to explain that the concept of carpospore of red algae is not correct, because sometimes they are diploid. Diploid spore should be called deutezygote, reproductive cell produced by the asexual reproduction of zygote.

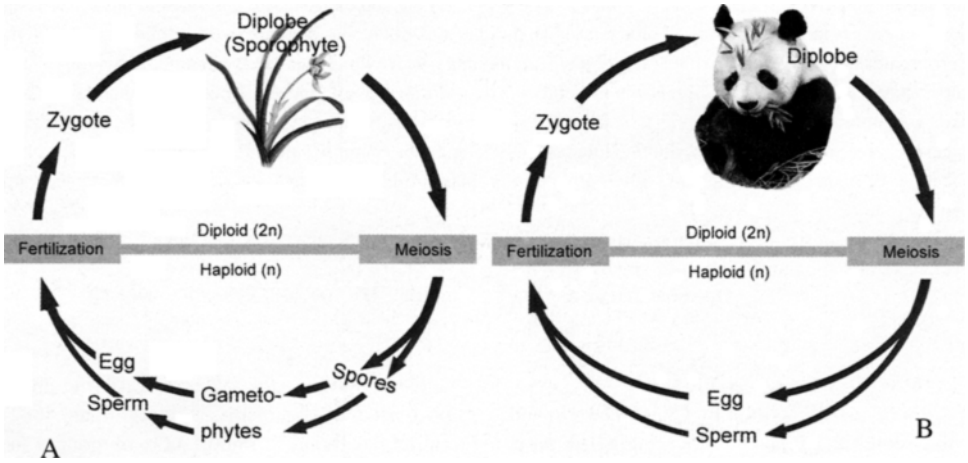

Fig. 1. The sexual reproduction of higher organisms
(A) sporogeny, (B) gametogeny

Plantae are embryonate, sessile and, autotrophic or sporogenic (Plantae, kingd. organismi embryonati, sessiles et, autotrophici vel sporogeni). The kingdom includes all higher plants and Nudembryophyta (Nudembryophyta, phyl. nov. embryones nudi.), a new phylum, whose embryos are nude. Phylum Nudembryophyta include all embryonate algae such as some brown, green and red algae.

Animals are embryonate, heterotrophic and, motile or gametogenic (Animalia, kingd. organismi embryonati, heterotrophici et, motiles vel gametogenici). The kingdom includes all multicellular animals such as Spongia, mesozoa and metazoa.

The new system reflects the two important phases of bioevolution and two branches of higher organisms, which is different from prior works. It gained increasing acceptance that higher organisms include the third Kingdom, Fungi, proposed by R. H. Whittaker (Stern *et al.* 2004; Liu and Mei 1997; Nicklin *et al.* 1999; Zhou 2002; Proscott *et al.* 2003; Whittaker 1969; Leedale 1974; Chen, Sh. X. & Chen, Sh. Y. 1979), besides Plantae and Animalia. But fungi are inembryonate, which don't have the same evolutionary meanings as plants and animals. So, fungi should be set in Microbia. Conversely, Nudembryophyta and Spongia are embryonate organisms and should be set in kingdom Plantae and Animalia respectively, but they were thought as lower organisms in prior taxonomic works. Also it gained increasing acceptance that lower organisms include several Kingdoms, which are Virus suggested by S. X. Chen, Archaea and Bacteria by C. Woese, Monera by H. F. Copeland, Archezoa and Chromista by T. Cavalier-Smith, Protoctista by J. Hogg and E. H. Haeckel and Protista by R. H. Whittaker. The confusion is inevitable if there are many kingdoms in lower organisms. The new system will really correct the problem that kingdoms are different in different researches or by different researchers.

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